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(12) **United States Patent**
Ichinohe et al.

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(54) **INTRAOCULAR LENS INSERTION DEVICE**

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Kazunori Kudo, Saku (JP)

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(73) Assignee: **Hoya Corporation**, Tokyo (JP)

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Primary Examiner — Jocelin Tanner

(74) Attorney, Agent, or Firm — Henricks, Slavin & Holmes LLP

(30) **Foreign Application Priority Data**

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(52) **U.S. Cl.**

CPC **A61F 2/167** (2013.01); **A61F 2/1678** (2013.01)

(58) **Field of Classification Search**

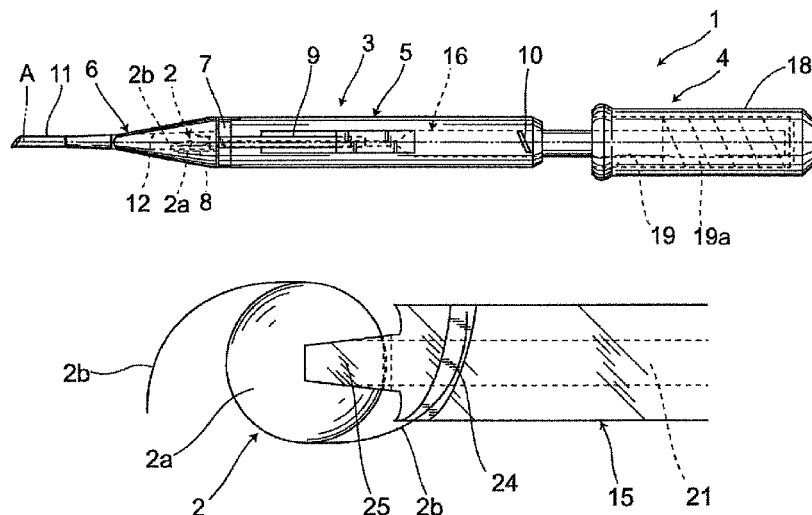
CPC A61F 2/1678; A61F 2/1672; A61F 2/148;
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USPC 606/107, 166, 108; 623/6.11, 6.12
See application file for complete search history.

(57)

ABSTRACT

An instrument for inserting an intraocular lens capable of securely and safely pushing out the lens by a simple structure. An instrument (1) for inserting comprises: a body (3) having a lens placement part (8) on which the lens (2) with a pair of loop parts (2b) at its optic part (2a) is installed, a transition part (12) deforming the lens (2), and a nozzle part (11) discharging the lens (2); and a lens push-out mechanism (4) pushing out the lens (2) placed on the lens placement part (8). The lens push-out mechanism (4) comprises a plunger (16) pushing out the lens (2) and a slider (15) having a lens contact part (20) larger than the plunger (16). The slider (15) comprises an operation part (23) projected to the outside of the body (3).

13 Claims, 9 Drawing Sheets



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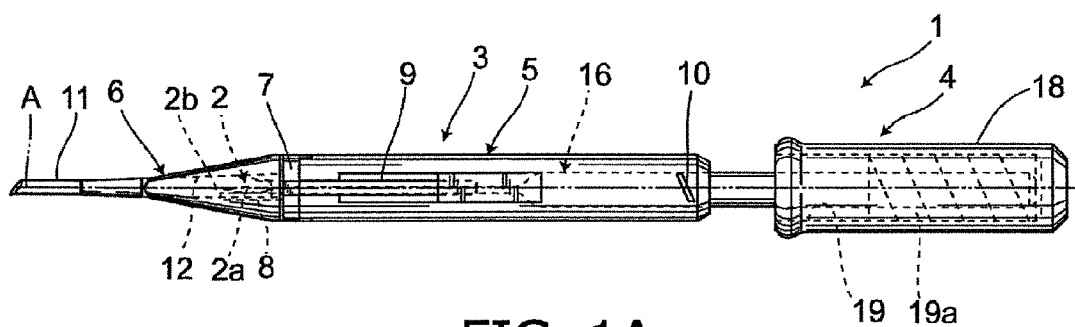


FIG. 1A

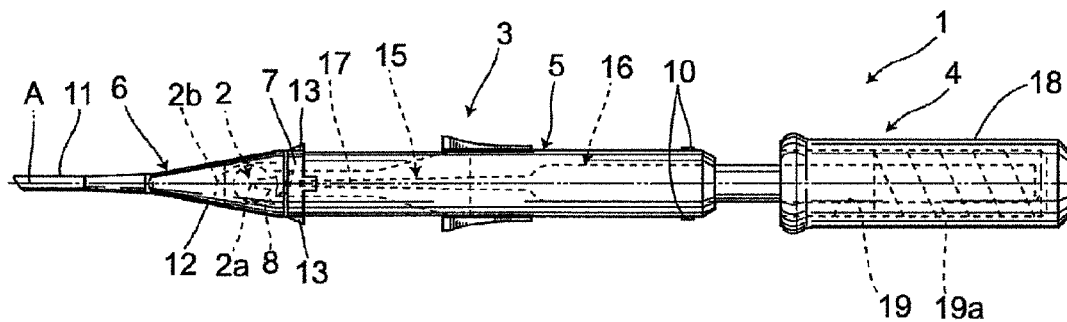
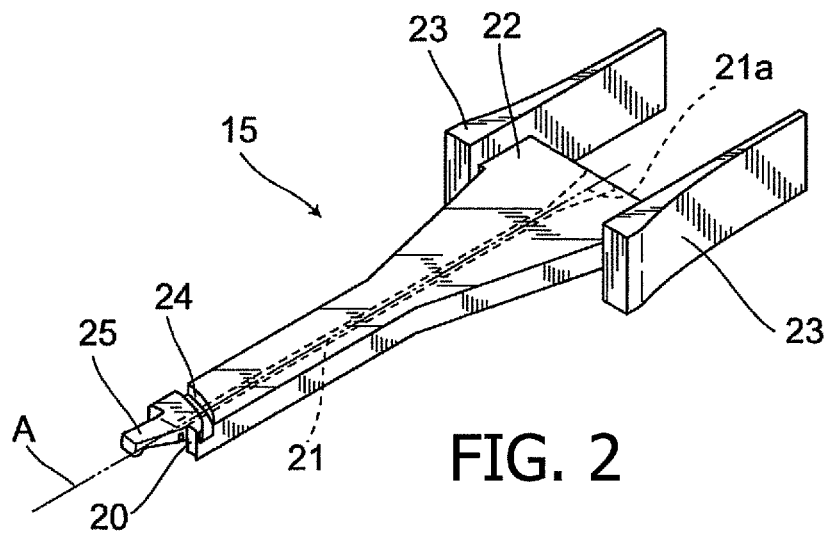


FIG. 1B



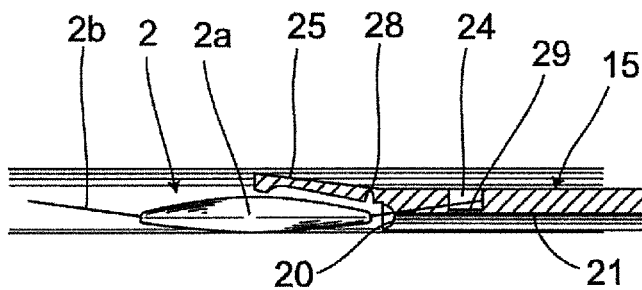


FIG. 3A

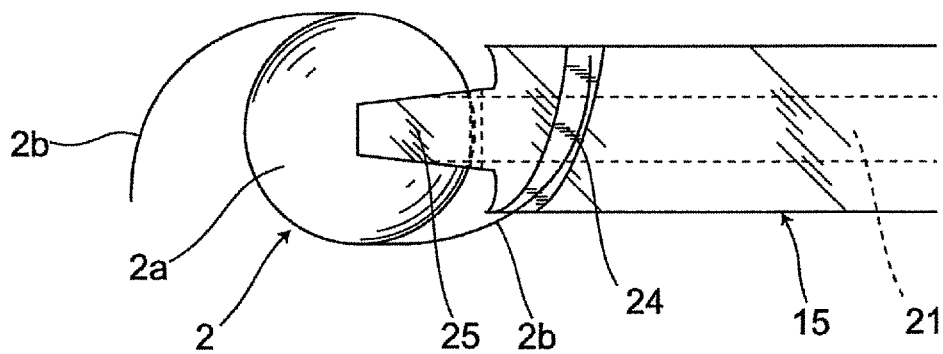


FIG. 3B

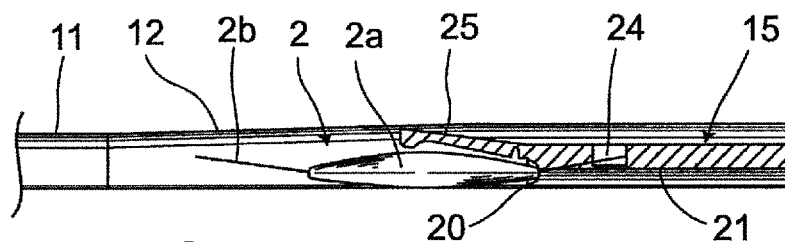


FIG. 4A

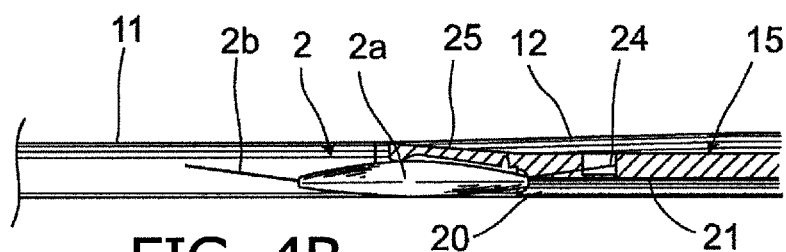


FIG. 4B

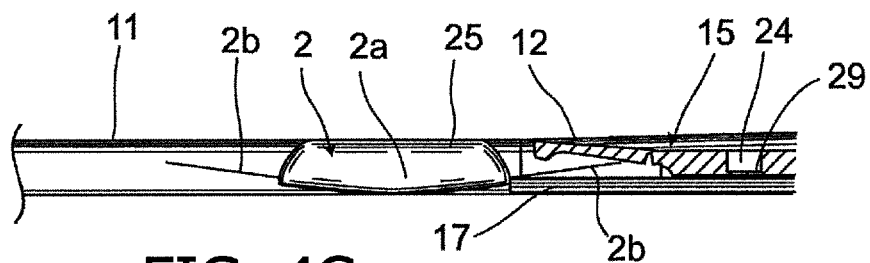


FIG. 4C

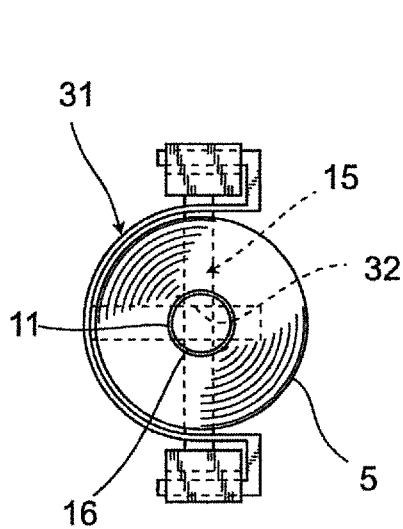


FIG. 5A

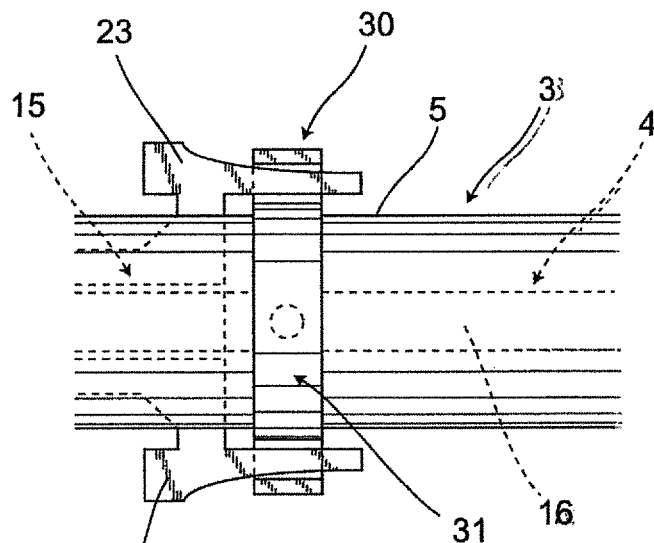


FIG. 5B

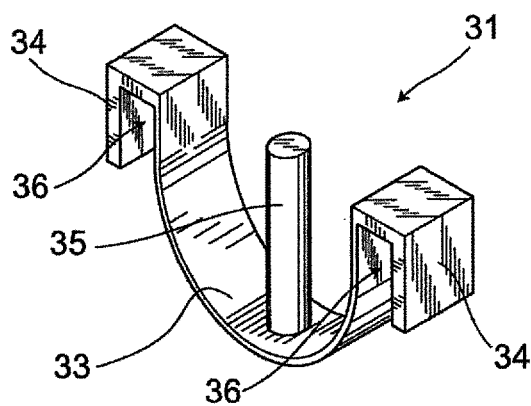


FIG. 6

FIG. 7A

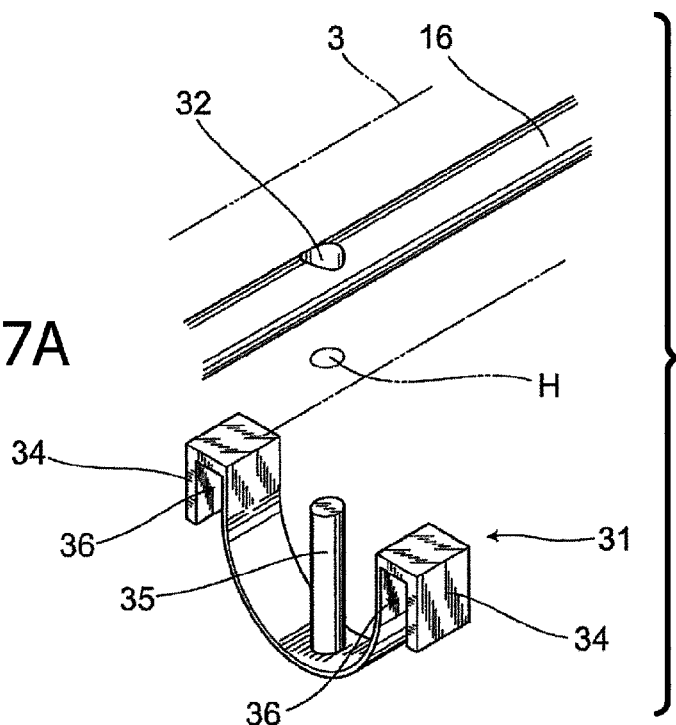


FIG. 7B

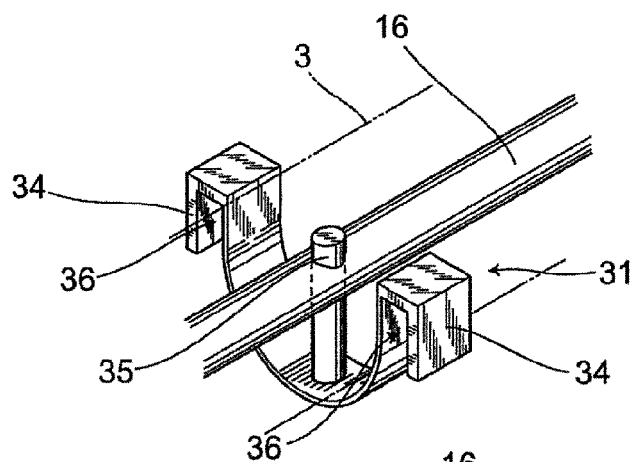
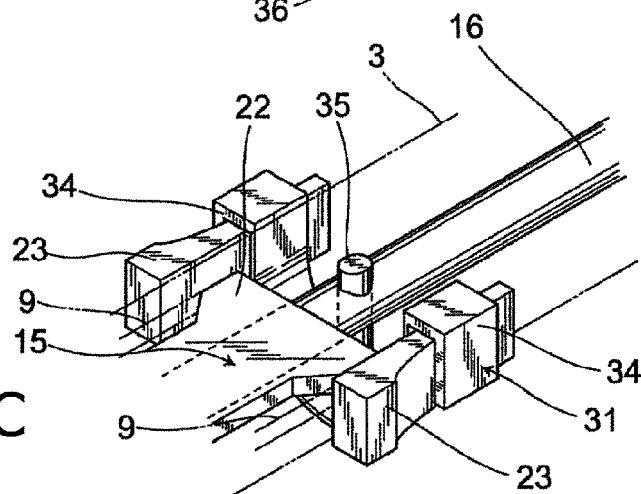


FIG. 7C



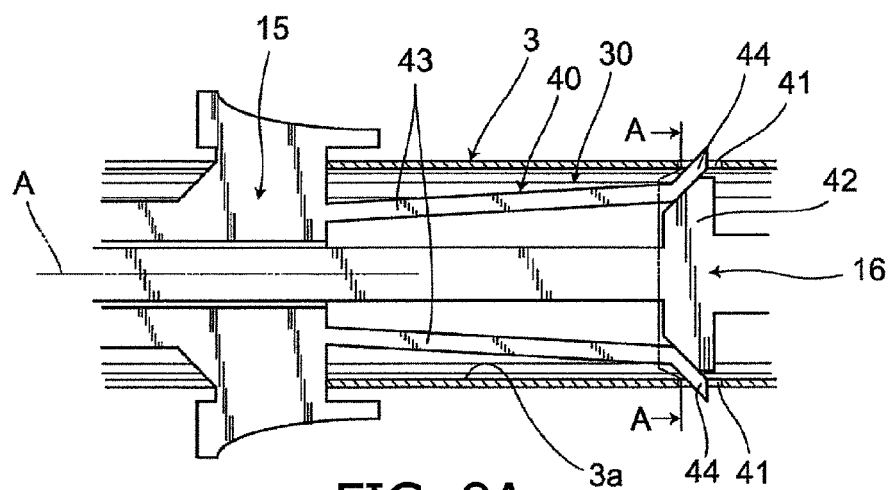


FIG. 8A

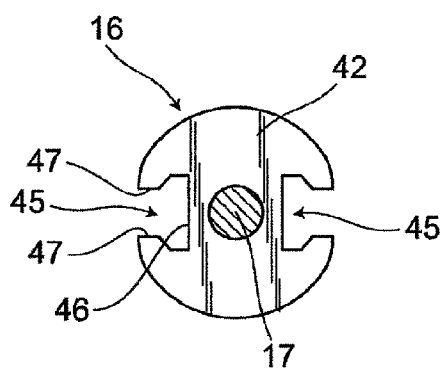


FIG. 8B

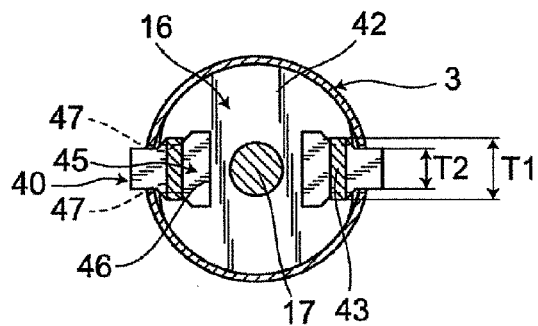


FIG. 8C

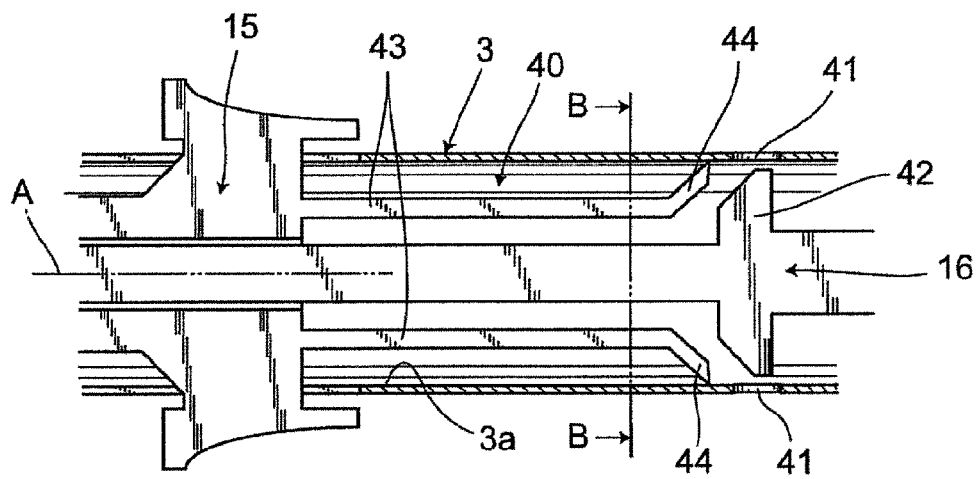


FIG. 9A

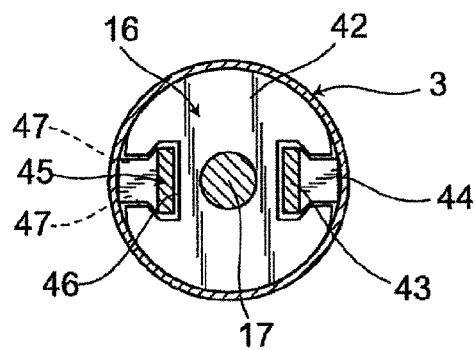


FIG. 9B

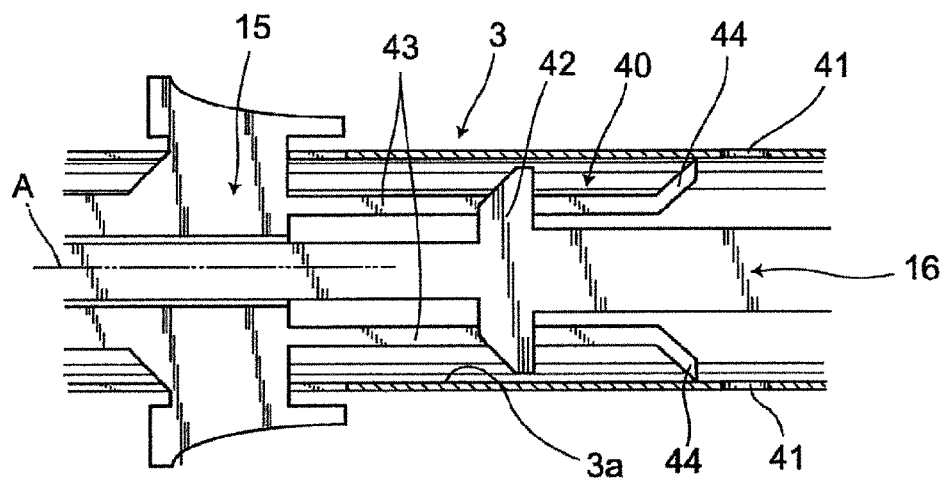


FIG. 10

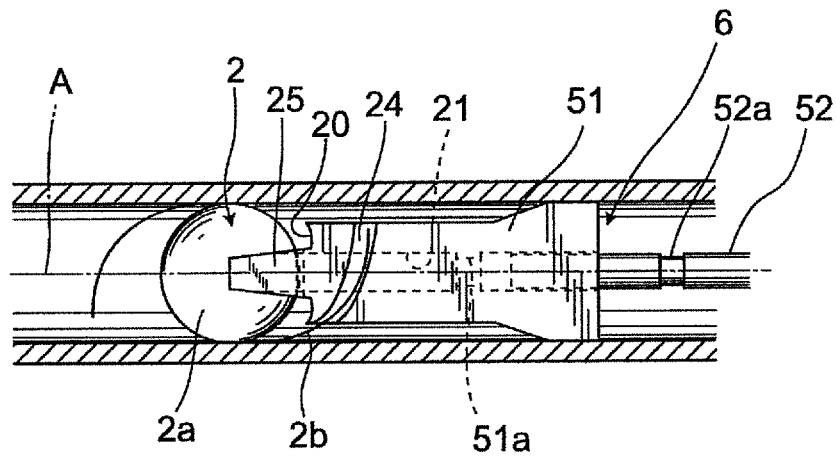


FIG. 11A

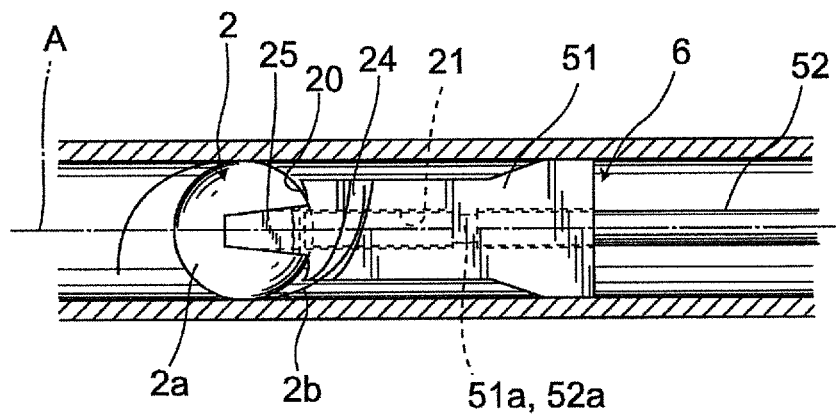


FIG. 11B

INTRAOCULAR LENS INSERTION DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/088,328, filed Mar. 27, 2008, now U.S. Pat. No. 8,574,239, which is a U.S. national phase application under 35 U.S.C. §371 of International Patent Application No. PCT/JP2006/319046 filed Sep. 26, 2006, which claims priority to Japanese patent application No. 2005-282311, filed Sep. 28, 2005. The International Application was published in Japanese on Aug. 3, 2006 as International Publication No. WO 2007/037223 A1. The content of each application is incorporated herein in its entirety.

TECHNICAL FIELD

The present invention relates to an intraocular lens insertion device that inserts an intraocular lens into an aphakic eye after a cataract operation, or, to an intraocular lens insertion device that inserts a phakic intraocular lens during a refractive surgery.

BACKGROUND ART

In cataract operations, removing an opacified lens by phacoemulsification (PEA) and implanting an intraocular lens after an opacified lens has been removed are widely performed. The types of intraocular lens include a hard intraocular lens with its optic area made of a hard material, such as PMMA, and a soft intraocular lens made of a soft material such as silicone elastomer or soft acrylic. When using a hard intraocular lens, the intraocular lens must be inserted through an incision in the cornea or sclera that is formed so as to have about the same width as the diameter of the optic area. On the other hand, when using a soft intraocular lens, folding of the optic area allows the intraocular lens to be inserted into the eye through an incision that is smaller than the diameter of the optic area. Inserting a lens from a small incision is desirable to reduce the post-surgery corneal astigmatism and infection, so there has been a trend in recent years to favor the soft intraocular lens. In addition, to insert the lens into the eye, there are cases where a special injector is used, said special injector having a structure provided with a long tube through which the lens passes as it is guided into the eye. Using such a special intraocular lens injector makes it possible to insert the lens through an incision smaller than 3 mm.

In addition, preset injectors having the lens set in the injector in advance to eliminate the risk of contamination by microbes during lens handling and of possible operational mistakes during lens handling have recently come to market. Some preset injectors are provided with a holding mechanism that holds the lens inside in a state that does not stress the optic area and with a lens movement mechanism that moves the lens to a position where it can be pushed out by an discharge device so as to transfer the lens from the lens immovable state during shipment to the lens movable state during use (For example, Patent Documents 1 and 2).

However, in the above patent documents 1 or 2, it is necessary to move the lens from the stationary position to a position where it can be pushed out during its use, and there is a fear of yielding operational mistake accompanying the movement operation. As a solution to such problems, there is disclosed an intraocular lens insertion device characterized in that a push-out shaft and a posture control member for preventing the shaft misalignment between the push-out shaft

and a lens are arranged in a manner capable of interlocking with each other, and such mutual interlocking is released at a prescribed position (For example, Patent Document 3). In this patent document 3, it is necessary to provide a special mechanism for releasing at a predetermined position the interlocking between the two members: the push-out shaft and the posture control member that are interlocked with each other within a closed space or an injector. Further, there is disclosed another intraocular lens insertion device characterized in comprising a mechanism for laterally compressing a flexible intraocular lens into a small cross-sectional configuration (For example, Patent Document 4).

Patent Document 1: Japanese Patent Application Laid-Open (JP-A) No. 2003-325570

Patent Document 2: JP-A No. 2003-325572

Patent Document 3: JP-A No. 2004-24854

Patent Document 4: JP-A No. 2001-502563

PROBLEMS TO BE SOLVED BY THE INVENTION

However, even in the above-mentioned Patent Document 3, there is a possibility that the interlocking is started and released outside the prescribed position, giving users a feeling of anxiety. In the case that the interlocking is released outside the prescribed position, for example short of the prescribed position, the posture control member also comes to stop short of the prescribed position. Thus, the position of the push-out shaft cannot be sufficiently controlled, thus leading to a possibility that a lens is pushed out with the axis of the push-out shaft being misaligned. On the other hand, a transition portion for folding a lens needs to be formed gently so that the lens is not subjected to a local load. If the interlocking is released by the contact of the transition portion with the posture control member, the position where the interlocking is released varies by the fluctuation of a slide friction. Accordingly, to perform the start and release of the interlocking at the prescribed portion, physical properties such as tensile strength of the push-out shaft and of the posture control member are limited, and high accuracy is required for each component, thus leading to concerns about high production costs. Furthermore, if the device is assembled with the interlocking of the push-out shaft and the posture control member having already been released beforehand by mistake in a production process, yet it is difficult to notice the assembly defect once it has been assembled, and thus, there has been a concern that it may be shipped as it is.

Moreover, referring to the above-mentioned Patent Document 4, it is primarily featured by the provision of retainers to maintain the opposing side edges of an intraocular lens in a substantially planar orientation so as not to damage the inside of the eye when releasing the intraocular lens in the eye from a compressed state. With such configuration employed, however, there has been a problem that too heavy load may be applied to the lens, which could damage the lens when the intraocular lens is pressed against the fine areas of a lens placing section and a tubular member.

Therefore, in view of the above mentioned problems, an object of the present invention is to provide an intraocular lens insertion device capable of securely and safely pushing out the lens by a simple structure.

SUMMARY OF THE INVENTION

To achieve the above object, the invention according to a first aspect of the invention is an intraocular lens insertion device characterized in comprising:

3

a main body comprising a lens placement portion to place an intraocular lens thereon, a transition portion to deform said intraocular lens and a nozzle portion to discharge said intraocular lens; and

a lens push-out mechanism to push out said intraocular lens placed on said lens placement portion,

wherein said lens push-out mechanism comprises a plunger to push out said intraocular lens and a slider having a lens contact part larger than said plunger, while said slider is provided with an operating part projected outwardly from said main body, and

wherein said intraocular lens is deformed by moving said slider by handling said operating part, and said intraocular lens is discharged from said nozzle portion by said plunger.

The invention according to a second aspect of the invention is characterized in that said operating part is projected outwardly from mutually opposed side surfaces of said main body.

The invention according to a third aspect of the invention is characterized in that said operating part is projected outwardly from one side of said main body.

The invention according to a fourth aspect of the invention is characterized in that said slider is provided with a lens holding part that holds one surface of an optic part of said intraocular lens and deforms said intraocular lens in a predetermined direction.

The invention according to a fifth aspect of the invention is characterized in that said lens holding part holds only the intraocular lens moved to said transition portion.

The invention according to a sixth aspect of the invention is characterized in that said lens holding part is connected with said slider via a hinge mechanism and is urged toward a sidewall of said main body, while said lens holding part is deformed toward the optic part of said intraocular lens through said transition portion.

The invention according to a seventh aspect of the invention is characterized in that said slider is provided with an inserting passage for inserting said plunger therethrough.

The invention according to an eighth aspect of the invention is characterized in that said intraocular lens comprises a pair of loop parts at said optic part, while said slider is provided with a loop guide to support said loop parts in such a condition that no physical load is applied thereto.

The invention according to a ninth aspect of the invention is characterized in that said slider is provided with a partition between said inserting passage and said loop guide.

The invention according to a tenth aspect of the invention is characterized in that a lock mechanism to lock said plunger is provided, said lock mechanism being constructed so that it can be unlocked by moving said slider.

The invention according to an eleventh aspect of the invention is characterized in that said lock mechanism is unlocked in association with the movement of said slider.

The invention according to a twelfth aspect of the invention is characterized in that said intraocular lens is sterilized with said intraocular lens being placed on said lens placement portion.

The invention according to a thirteenth aspect of the invention is characterized in that said main body is provided with a stopper to stop said slider at a predetermined position.

According to the intraocular lens insertion device as set forth in the first aspect of the invention, the slider is moved by handling the operating part, and then the intraocular lens is discharged by the plunger. Accordingly, the push-out operation of the intraocular lens can be performed securely and safely, with a simpler structure. According to the intraocular lens insertion device as set forth in the second aspect of the

4

invention, the slider can be moved by pinching the operating part with fingers from both sides, and thus reliability of the operation can be improved.

According to the intraocular lens insertion device as set forth in the third aspect of the invention, the slider can be moved by one hand, thus enabling more easier handling.

According to the intraocular lens insertion device as set forth in the fourth aspect of the invention, the intraocular lens can be folded in a predetermined direction, thus preventing operation troubles, ensuring even more reliable insertion of the intraocular lens.

According to the intraocular lens insertion device as set forth in the fifth aspect of the invention, the optic part of the intraocular lens is pressed down only at the time of use, and the lens holding part does not press down the optic part of the lens in an intact state, and thus permanent deformation of an elastic material can be suppressed even after a long period of preservation.

According to the intraocular lens insertion device as set forth in the sixth aspect of the invention, one surface of the intraocular lens moved to the transition portion can be pressed down with a simple structure. Further, since the lens holding part is urged toward the sidewall of the main body, there is a further advantage in terms of assembly process that the intraocular lens can be placed on a lens placement portion easily.

According to the intraocular lens insertion device as set forth in the seventh aspect of the invention, the slider is provided with the inserting passage, and thus the discharge of the intraocular lens can be ensured, by preventing the axial misalignment of the plunger.

According to the intraocular lens insertion device as set forth in the eighth aspect of the invention, the intraocular lens can be positioned in a predetermined position by the engagement of the loop parts with the loop guide. Further, since the loop parts are not pushed by the slider, deformation and damage of the loop parts can be prevented.

According to the intraocular lens insertion device as set forth in the ninth aspect of the invention, the plunger is not allowed to abut onto the loop parts, and thus, the loop parts can be prevented from being damaged by the pressing by the plunger.

According to the intraocular lens insertion device as set forth in the tenth aspect of the invention, it is possible to prevent an operator from pushing out the plunger accidentally prior to moving the slider, thus enabling the reliability of operation to be improved.

According to the intraocular lens insertion device as set forth in the eleventh aspect of the invention, the lock mechanism is unlocked in association with the movement of said slider, thus enabling the operability to be improved.

According to the intraocular lens insertion device as set forth in the twelfth aspect of the invention, it is possible to prevent the lens from being contaminated with other substances, thus improving safety.

According to the intraocular lens insertion device as set forth in the thirteenth aspect of the invention, the slider is stopped at a predetermined position by the stopper, thus enabling further improvement of the operational reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are side and plan views, respectively, of an intraocular lens insertion device according to a first embodiment of the present invention.

FIG. 2 is a perspective view showing a structure of a slider.

5

FIGS. 3A and 3B are longitudinal cross-sectional and plan views, respectively, showing a positional relationship between the slider and a lens.

FIGS. 4A-4C are partially enlarged longitudinal section views illustrating the operation of the push out mechanism progressively.

FIGS. 5A and 5B are front and bottom views, respectively, of an intraocular lens insertion device according to a second embodiment of the present invention.

FIG. 6 is a perspective view showing a structure of a locking member.

FIGS. 7A-7C are perspective views progressively illustrating the locking operation of a plunger.

FIGS. 8A-8C are a fragmentary transverse section view, a longitudinal section view, and a cross-section taken along line A-A in FIG. 8A, respectively, of an intraocular lens insertion device according to a third embodiment of the present invention.

FIG. 9A is a transverse cross-section view of the intraocular lens insertion device in an unlocked state, and FIG. 9B is a cross-section view taken along line B-B in FIG. 9A.

FIG. 10 is a transverse cross-section showing the intraocular lens insertion device with the plunger being pushed out in an unlocked state.

FIGS. 11A and 11B are transverse cross-section views respectively showing an intraocular lens insertion device according to a fourth embodiment of the present invention in a state prior to the interlocking of the slider with the plunger and with the slider and the plunger moving together after being interlocked with each other.

BEST MODE FOR CARRYING OUT THE INVENTION

Next is a description of preferred embodiments of the present invention with reference to the attached drawings.

First Embodiment

First, a first embodiment of the present invention is explained. An intraocular lens insertion device 1 shown in FIGS. 1A and 1B is used to safely and quickly discharge into an eye a deformable intraocular lens 2 (hereinafter referred to as "lens 2"), and more particularly is a preset type intraocular lens insertion device 1 having the lens 2 preset in the intraocular lens insertion device 1. More specifically, the intraocular lens insertion device 1 is provided with a main body 3 that places the lens 2 therein and then inserts the lens 2 into an eye, and a lens push-out mechanism 4 that pushes out the lens 2 placed in the lens placement portion. In the meantime, for the lens 2 illustrated in the present embodiment is employed one comprising an optic part 2a and loop parts 2b.

Said main body 3 comprises a cylindrical proximal member 5 and a distal member 6 that is tapered relative to the proximal member 5. This proximal member 5 and the distal member 6 are detachably integrated with each other in an engagement section 7. It should be noted that the main body 3 may be made from various materials. For example, it may be made not only from stainless steel or titanium, but from a synthetic resin or the like.

The proximal member 5 comprises a lens placement portion 8 provided at one end thereof and a slit 9 formed in a cylindrical side wall and elongated in the longitudinal direction thereof. The lens placement portion 8 comprises a tabular member provided at the one end of the proximal member 5 in a protruding condition. The slit 9 is formed from an edge of the one end of the proximal member 5 to the substantial center

6

thereof. Moreover, an engagement projection 10 with which a hereinafter-described grip section engages is provided on an outer peripheral surface of the proximal member 5.

The distal member 6 comprises a nozzle portion 11 that is to insert the lens 2 placed in said lens placement portion 8 into an eye, and a transition portion 12 connecting said nozzle portion 11 with said proximal member 5. The transition portion 12 has a mortar shape such that it tapers toward a distal end, and is connected with the nozzle portion 11 at the distal end. The nozzle portion 11 is formed to have an outer diameter that is substantially of the same size as the width of an incision. The lens 2 is pushed out by the lens push-out mechanism 4 and then folded when it passes through said transition portion 12. The distal member 6 is provided with a stopper 13 for stopping a hereinafter-described slider in a predetermined position. This stopper 13 comprises a projection that is to engage with an operating part of the slider.

Said lens push-out mechanism 4 comprises the slider 15 to perform an initial operation for inserting the lens 2, and a plunger 16 to insert the lens 2 into an eye.

The plunger 16 is used to insert into an eye the lens 2 folded up by said slider 15, and comprises a push-out rod 17 to push out the lens 2, and a grip part 18 provided at the proximal end of said push-out rod 17. Said push-out rod 17 is loosely fitted into a hole 19 formed through the grip part 18, and is axially supported by the grip part 18 at the bottom of the hole 19. This hole 19 is formed with a female screw 19a. The female screw 19a formed in the grip part 18 is constituted so that it may screw together with said engagement projection 10. The engagement projection 10 is provided in the form of a partial male screw that is to be screwed into said female screw 19a. Due to the engagement projection 10 being provided in the form of a partial male screw thus way, it is possible to prevent the engagement projection 10 from interfering with said slit 9 etc., while ensuring the grip part to be pushed in reliably as a result of the engagement with the female screw 19a. Thus, such construction is provided that the grip part 18 pushes out the push-out rod 17 toward the direction of a lens movement axis A. The grip part 18 is formed in a shape that facilitates the pushing-out action of the plunger 16.

The slider 15 is constituted so that it can fold up the lens 2 in a predetermined direction, while pushing out the lens 2 placed in the lens placement portion 8 toward the distal end of the main body 3 without applying local load to the lens 2, as shown in FIG. 2. This slider 15 includes a lens abutting portion 20 abutted on the lens 2 in a larger area than said plunger 16, a guide groove 21 serving as an inserting passage that supports said plunger 16 along the lens movement axis A, a wing part 22 that engages with the slit 9 provided in the main body 3 and guides the slider 15 along the lens movement axis A, an operating part 23 for pushing the slider 15 in and out, a loop guide 24 that fastens loop parts 2b of the lens 2, and a lens holding part 25.

Said lens abutting portion 20 is formed of a part of circle that has substantially the same radius of curvature as the outer diameter of the lens 2, such that it is allowed to come in surface contact with the lens 2, enabling the initial operation to be performed smoothly, without giving a local stress to the lens 2.

Said guide groove 21 is formed so as to allow said plunger 16 to be slidable thereon, and to allow the distal end of said plunger 16 to be able to protrude from said lens abutting portion 20. The guide groove 21 is formed substantially in the center on one surface of the slider 15 over the entire length thereof, and comprises a groove arranged parallel to the lens movement axis A. The section of the guide groove 21 is substantially formed in the same shape as the contour of said

7

plunger 16. A fan-shaped introduction passage 21a is formed at the proximal end of the guide groove 21. Thus, the push-out rod 17 is inserted through the guide groove 21 formed in said slider 15, and is allowed to slide within the guide groove 21 in the longitudinal direction of the slider 15. In the meantime, the guide groove 21 may be a through-hole that penetrates in parallel with the lens movement axis A.

The engagement of said wing part 22 with said slit 9 enables said slider 15 to be held substantially in the center of the main body 3, while enabling the slider 15 to move along the lens movement axis A. Accordingly, the plunger 16 is held in the center of the main body 3, and made movable along the lens movement axis A by the guide groove 21. The movement of the slider 15 is easily carried out through said operating part 23.

The operating part 23 is provided as a pair, at right and left sides relative to the lens movement axis A, and provided adjacent to the edge of said wing part 22 in a manner protruding outwardly from said proximal member 5. The operating part 23 is formed so as to bulge outwardly toward the distal end of said main body 3. Although not shown in the drawings, the surface of the operating part 23 is formed with two or more longitudinal grooves, extending substantially at right angles to the lens movement axis A.

Said loop guide 24 is formed on another surface of said slider 15 on which said guide groove 21 is not formed, and serves to fix the lens 2 by fastening the loop part 2b of the lens 2 therein. This loop guide 24 comprises a groove formed similar in shape to the curved loop part 2b, such that it is formed at the distal side of the slider 15 in such a curved shape that a physical load may not be applied to the loop part 2b.

The lens holding part 25 enables the lens 2 to be folded up in a predetermined direction by pressingly holding one surface of the lens 2 only when pushing out the lens 2. That is, by pressing the one surface of the lens 2 that is to become a front surface thereof when inserted into an eye, using the lens holding part 25, the lens 2 is folded with the one surface thereof being inside, within the nozzle portion 11. Accordingly, the lens 2 can be deformed into such a shape that allows the lens 2 to be reliably inserted into a lens capsule. As shown in FIGS. 3A and 3B, this lens holding part 25 is provided at the distal end of the slider 15 through a hinge mechanism 28, and is provided in a manner capable of being tilted up and down in a side view. The hinge mechanism 28 is formed of a tapered groove provided by thinning a joint portion between the lens holding part 25 and the lens abutting portion 20 in the width direction of the slider 15. The lens holding part 25 is urged upwards in a side view, through this hinge mechanism 28, thus enabling the lens 2 to be folded in a predetermined direction by holding one side of the lens 2 when the lens 2 moves within the nozzle portion 11.

Moreover, said loop guide 24 is formed so that the plunger 16 may not abut to the loop part 2b. More specifically, a partition 29 is formed between the guide groove 21 formed on the one side of the slider 15 and the loop guide 24 formed on the other side of the slider 15. Accordingly, the plunger 16 is not allowed to abut to the loop part 2b engaged with the loop guide 24, thus preventing the damage of the loop part 2b caused by the loop part 2b being pushed by the plunger 16.

Next, is a description of an assembling procedure of the intraocular lens insertion device 1 structured in this way. First, the slider 15 is attached to the proximal member 5. In order to attach the slider 15 to the proximal member 5, the wing part 22 is allowed to be fitted into the slit 9 from the edge of the one end of the proximal member 5, and the slider 15 is pushed in up to the proximal end of the slit 9. Subsequently, the plunger 16 is inserted from the other end of the proximal

8

member 5. At that moment, the distal end of the plunger 16 is aligned with such a position that it does not project from the distal end of the slider 15 placed in the proximal member 5. Then, the loop part 2b of the lens 2 is fastened by the loop guide 24 formed in the slider 15, and the lens 2 is placed in the lens placement portion 8. The lens 2 placed in the lens placement portion 8 is arranged in such a condition that the lens holding part 25 does not abut to the optic part 2a of the lens 2 due to the lens holding part 25 being urged toward an inner wall of the distal member 6 by the hinge mechanism 28, as shown in FIG. 3A. Subsequently, the distal member 6 and the proximal member 5 are integrated with each other in the engagement section 7. Thus, the intraocular lens insertion device 1 can be assembled reliably, without applying a load to the lens 2.

Then, the intraocular lens insertion device 1 with the lens 2 being attached as mentioned above, is sterilized, which is carried out by placing the intraocular lens insertion device 1 into a sterilization bag (not shown), and filling the interior of the bag with ethylene oxide gas (hereinafter called EOG). Since EOG enters into the intraocular lens insertion device 1 from the slit 9 due to the provision of the slit 9 in the sterilization bag filled with EOG, it is possible to introduce EOG into the inside even though no specific hole for introducing sterilization EOG into the inside is provided, thus ensuring full sterilization up to the inside.

Next, the action of the above-mentioned structure will be explained. After taking out the intraocular lens insertion device 1 from the sterilization bag, the operating part 23, at first, is pushed out and thus the slider 15 is moved in the direction of the lens movement axis A (FIG. 4A). Upon the movement of the slider 15, the lens holding part 25 is pressed by the inner wall of the transition portion 12, and tilted downward in a side view, thereby pressingly holding the one surface of the optic part 2a of the lens 2 (FIG. 4B). When the slider 15 pushes out the lens 2, the lens holding part 25 presses down the one surface of the optic part 2a, thus enabling the lens 2 to be folded in the predetermined direction. The plunger 16 is pushed out after the slider 15 abuts to the stopper 13 and then stops (FIG. 4C). In order to push out the plunger 16, first, the grip part 18 is pushed out, and the female screw 19a is engages with the engagement projection 10 by screwing. Subsequently, the grip part 18 is rotated. Upon the rotation of the grip part 18, the grip part 18 is moved in the direction of the lens movement axis A from the other end of the proximal member 5, and thus the push-out rod 17 is pushed by the grip part 18 to move in the direction of the lens movement axis A, thus pushing out the plunger 16. In this way, the lens 2 is folded up by being pushed by the plunger 16 and passing through the thin nozzle portion 11. Thus, pushing out the plunger 16 further with the lens 2 being folded allows the lens 2 to be inserted into an eye. Since the partition 29 is provided between the guide groove 21 and the loop guide 24 when pushing out the plunger 16, it is possible to prevent the damage of the loop part 2b due to the plunger 16 not pushing the loop part 2b.

According to the present embodiment as mentioned above, the intraocular lens insertion device 1 comprises: the main body 3, including the lens placement portion 8 that places the lens 2 therein, the transition portion 12 to deform said lens 2, and the nozzle portion 11 to introduce said lens 2; and the lens push-out mechanism 4 that pushes out the lens 2 placed in said lens placement portion 8, wherein said lens push-out mechanism 4 comprises: the plunger 16 that pushes out the lens 2; and the slider 15 having the lens abutting portion 20 larger than this plunger 16, while said slider 15 includes the operating part 23 projected outwardly from said main body 3,

and the lens 2 is deformed by moving said slider 15 through the operation of said operating part 23 so that said lens 2 is discharged from said nozzle portion 11 by said plunger 16, whereby the discharge operation of the lens 2 can be performed reliably and safely with simpler structure.

Moreover, since said operating part 23 is provided so as to project outwardly from each opposite side surface of said main body 3, it is possible to move the slider 15 with the operating parts 23 being pinched with fingers from both sides, thereby enabling the improvement of the reliability of the operation.

Still moreover, since said slider 15 comprises the lens holding part 25 that presses down the one surface of the optic part 2a of the lens 2 to deform said lens 2 in the predetermined direction, it is possible to fold up the lens 2 in the predetermined direction, thus preventing problems associated therewith, enabling the lens 2 to be inserted into an eye more reliably.

Further, since said lens holding part 25 is constituted so as to press down only the lens 2 that has moved to the transition portion 12, the optic part 2a of the lens 2 is pressed down only at the time of use, and the lens holding part 25 does not press down the optic part 2a of the lens 2 in an intact state, and thus permanent deformation of an elastic material can be suppressed even after a long period of preservation.

Still further, said lens holding part 25 is connected with said slider 15 through the hinge mechanism 28, and is urged toward the side wall of said main body 3 so that it may be deformed toward the optic part 2a of said lens 2 through said transition portion 12, it is possible to press down the one surface of the lens 2 reliably, only when it moves to the transition portion 12, with simpler structure.

Furthermore, since said slider 15 comprises the guide groove 21 for inserting said plunger 16 therethrough, it is possible to prevent axial misalignment of the plunger 16, ensuring the reliable discharge of the lens 2.

Also, said lens 2 comprises the optic part 2a with a pair of the loop parts 2b, while said slider 15 comprises the loop guide 24 that supports said loop parts 2b in such a condition that no physical load is applied thereto, whereby it is possible to position the lens 2 in a predetermined location by engaging the loop parts 2b with the loop guide 24, while enabling the preventing of the deformation of the loop parts 2b due to the loop parts 2b being not pressed by the slider 15.

Besides, since said slider 15 is formed with the partition 29 between said inserting passage and said loop guide 24, the slider 15 does not abut to the loop part 2b, thus enabling the loop part 2b to be prevented from being damaged by the pressing by the slider 15.

Moreover, since the lens 2 is sterilized with the same being placed in the lens placement portion 8, it is possible to prevent the same from being contaminated with other substances, thus improving safety.

Also, since said main body 3 comprises the stopper 13 that stops said slider 15 in a predetermined position, stopping the slider 15 in a predetermined position using the stopper 13 enables the further enhancement of the reliability of the operation.

Still also, since the lens holding part 25 is provided in a manner capable of being tilted up and down through the hinge mechanism 28, the optic part 2a of the lens 2 is pressed down only when pushing out the slider 15 to move the lens 2, thus enabling the lens 2 to be preserved without applying unnecessary load thereto.

Alternatively, the operating part 23 may be projected outwardly from only one side of said proximal member 5. In that

case, the operating part 23 can be operated with one hand to move the slider 15, usability of the device can be improved.

As the operating part 23 is formed so as to bulge outwardly toward the distal end of said main body 3, while the surface thereof is formed with two or more longitudinal grooves, increased frictional resistance is resulted when operating the operating part 23 with fingers, thus preventing slippage, enabling the improvement of the reliability of operation.

Besides, since the fan-shaped introduction passage 21a is provided at the proximal end of the guide groove 21, the plunger 16 can be easily inserted through the guide groove 21 when attaching the plunger 16.

In addition, since the plunger 16 is axially supported by the grip part 18, the plunger 16 does not rotate even when the push-out rod 17 is pushed out in the direction of the lens movement axis A while rotating the grip part 18, whereby the lens 2 can be pushed out smoothly, without the plunger 16 rotating.

Second Embodiment

Next, a second embodiment of the present invention will be explained. The same portions as those described in the above-mentioned structure will be designated by the same reference numerals, and the duplicate description thereof will be omitted. Specifically, the intraocular lens insertion devices of the first and second embodiments are common in the sense that they comprise the main body 3 for placing the lens 2 and inserting the lens 2 into an eye; and the lens push-out mechanism 4 that pushes out the lens 2 placed in said lens placement portion 8, while the second embodiment differs from the first embodiment only in that it comprises a lock mechanism 30.

The lock mechanism 30 locks the plunger 16, and is capable of being unlocked only when the slider 15 is pushed out (FIGS. 5A and 5B). The lock mechanism 30 comprises a lock member 31 provided in a detachable manner and a lock reception portion 32 provided in the plunger 16.

As shown in FIG. 6, the lock member 31 comprises a locking body 33 that is formed in a curved shape, an arm 34 integrally provided at both sides of the locking body 33, and a locking element 35 vertically provided substantially in the center of an inside area of the locking body 33. The locking body 33 has a curved shape slightly larger than the contour of the cylindrical main body 3, and is fitted thereto from outside. The arms 34 are formed by folding the ends of the locking body 33 so that a clearance 36 to insert said operating part 23 of the slider 15 therethrough is formed between each arm 34 and the outside portion of the locking body 33. The locking element 35 is composed of a cylindrical member extending vertically from the inside of the locking body 33, and is fitted to the lock reception portion 32 provided in the plunger 16. The lock reception portion 32 comprises a through-hole formed in the plunger 16. Alternatively, the locking member 35 is not limited to take a columnar shape, but may be also formed in a shape of a polygon, such as a square pillar. In that case, the lock reception portion 32, needless to say, is formed in accordance with the shape of the locking element 35.

Next is a description of a procedure for attaching the above-structured lock mechanism 30 with reference to FIGS. 7A-7C. First, the lock member 31 is attached, from the bottom side, to the main body 3 with the plunger 16 inserted therein (FIG. 7A). That is, the locking element 35 is inserted from a hole H formed beforehand on the main body 3, and then the distal end of the locking element 35 is fitted to the lock reception portion 32 provided in the plunger 16, to thereby attach the lock member 31 to the main body 3 (FIG. 7B). Thus way, the plunger 16 is locked relative to the main

11

body 3 through the locking element 35 inserted through the hole H formed in the main body 3.

Subsequently, the wing part 22 is allowed to engage with said slit 9, and then the slider 15 is pushed in up to the proximal end of the slit 9. When the slider 15 is pushed in, the operating part 23 is inserted into the clearance 36 formed between the arm 34 and the outside of the locking body 33 (FIG. 7C). When the operating part 23 is inserted into the clearance 36 thus way, the lock member 31 is fixed by the slider 15. In other words, the lock member 31 is fixed by the arm 34 engaging with the operating part 23 of the slider 15 under such a condition that the locking body 33 is abutted to the main body 3.

The lock mechanism 30 thus attached is unlocked in accordance with the reverse procedure to the above-mentioned procedure. First, the slider 15 is pushed out toward the distal end. Then, the operating part 23 is moved away from the arm 34, and thus the engagement therebetween is released. The lock member 31 can be pulled apart toward the bottom side, only after the engagement of the operating part 23 with the arm 34 is released. Thus, since the lock mechanism 30 can be unlocked only when the slider 15 is pushed out toward the distal side, i.e., only when the lens 2 is inserted into an eye, and thus improved safety can be achieved.

As discussed above, according to the present embodiment, the intraocular lens insertion device 1 comprises the lock mechanism 30 to lock said plunger 16, and said lock mechanism 30 is constituted such that it is able to be unlocked by moving the slider 15, whereby it is possible to prevent an operator from pushing out the plunger 16 accidentally prior to moving the slider 15, thus enabling the safety and reliability of operation to be improved.

Third Embodiment

Next, a third embodiment of the present invention will be explained. The same portions as those described in the above-mentioned structure will be designated by the same reference numerals, and the duplicate description thereof will be omitted. Specifically, the intraocular lens insertion device of the third embodiment is the same as the ones of the foregoing embodiments in that it comprises the main body 3 for placing the lens 2 and inserting the lens 2 into an eye; and the lens push-out mechanism 4 that pushes out the lens 2 placed in said lens placement portion 8, except the structure of the lock mechanism 30 described in the second embodiment.

The lock mechanism 30 (FIGS. 8A-8C) serves to locks the plunger 16, and is capable of being unlocked in association with the operation for pushing out the slider 15. This lock mechanism 30 comprises an engagement portion 40 provided in the slider 15, an engagement hole 41 for engagement with the engagement portion 40, and a disk part 42 provided in the plunger 16.

The engagement portion 40 is provided as one pair, on right and left sides with respect to the lens movement axis A, respectively, and comprises a rocking piece 43 elongated from the rear end of the slider 15 toward the other end side of the main body 3, and a latching piece 44 provided at the distal end of the rocking piece 43. This latching piece 44 is bent toward the outside of the main body 3, and locked through the engagement with said engagement hole 41, protruding therefrom toward the outside of the main body 3. The rocking piece 43 is provided in a manner capable of rocking toward the inside and outside of the main body 3 in a plan view, and thus it is formed so that it may be arranged parallel to the lens movement axis A when said latching piece 44 abuts to the inner side 3a of the main body 3. The width T1 of the rocking

12

piece 43 is formed greater than the width T2 of the latching piece 44. In the meantime, the latching piece 44 is constituted so that the angle of the rocking piece 43 relative to the latching piece 44 is an obtuse angle.

The disk part 42 is formed concentrically relative to the push-out rod 17, and is provided with a pair of transverse grooves on right and left sides around the push-out rod 17. Each transverse groove 45 is similar in shape to said engagement portion 40, and is provided with a bottom 46 that is broadened toward the center of the push-out rod 17 and a pair of protrusions 47 in a peripheral edge of the disk part 42. Thus, the plunger 16 is locked by the protrusions 47 abutting to said rocking piece 43.

Next is a description of the action of the above-mentioned structure. First, the slider 15 is pushed out toward the distal end. When the slider 15 is pushed out thus way, the latching piece 44 then abuts onto the engagement hole 41 so that it is arranged at an obtuse angle to the rocking piece 43, thereby allowing the same to slide along the inner edge of the engagement hole 41. Then, the rocking piece 43 is rocked toward the inside of the main body 3. When the slider 15 is further pushed out toward the distal end, the latching piece 44 is allowed to go beyond the engagement hole 41, so that the distal end of the latching piece 44 abuts on the inside surface of the main body 3. When the distal end of the latching piece 44 abuts on the inside surface of the main body 3 thus way, the rocking piece 43 is arranged parallel to the lens movement axis A, and thus the rocking piece 43 moves to the position of the bottom 46 of each transverse groove 45 as viewed from front, thus releasing the lock (FIGS. 9A and 9B). Upon the releasing of the lock in this way, the plunger 16 is allowed to push out the lens 2 due to the disk part 42 passing the engagement portion 40 (FIG. 10).

According to the present embodiment, the intraocular lens insertion device 1 is constituted such that said lock mechanism 30 is unlocked in association with the movement of said slider 15, thus enabling the operability to be improved.

Alternatively, a guide groove (not shown) to guide the latching piece 44 may be provided inside the main body 3. Such guide groove, extending from the engagement hole 41 in the direction of the lens movement axis A, comprises a groove with which the distal end of said latching piece 44 engages. The provision of such guide groove on the inside of the main body 3 can prevent the slider 15 from rotating about the lens movement axis A even when the lock is released by the movement of the slider 15, thereby ensuring the disk part 42 to pass the engagement portion 40 in order for the plunger 16 to be able to push out the lens 2.

The present invention is not limited to the foregoing embodiments, and various modifications are possible within the scope of the present invention. Although the proximal member 5 and the plunger 16 are screwed together in the foregoing embodiments, the invention should not be limited thereto, but the plunger 16 may be provided with a packing so that it may slide within the proximal member 5 through such packing. Moreover, although the locking element 35 is a columnar member and the lock reception portion 32 is a through-hole formed in the plunger 16 in the foregoing embodiment, the invention should not be limited thereto, but the locking element 35 may be a two-forked support pillar member, while the lock reception portion 32 may be a groove formed at a right angle to the longitudinal direction of the plunger 16. Alternatively, an urging member such as a coil spring may be mounted in order to urge the plunger 16 toward the proximal end of the main body 3.

Fourth Embodiment

Next, a fourth embodiment of the present invention will be explained with reference to (FIG. 11A). The same portions as

13

those described in the above-mentioned structure will be designated by the same reference numerals, and the duplicate description thereof will be omitted. The slider **51** according to the present embodiment is not provided with the operating part, and a lens push-out mechanism **6** is provided with a slider **51** and a plunger **52** in a manner capable of interlocking with each other. Said slider **51** is provided with the guide groove **21** formed along the lens movement axis A, while a convex portion **51a** is provided in the guide groove **21**. A concave portion **52a** that engages with said convex portion **51a** is formed in a circumference of said plunger **52**. This plunger **52** is inserted through said guide groove **21**, and is arranged in a manner capable of moving back and forth with respect to the lens movement axis A.

When the plunger **52** is moved forth in the above-structured lens push-out mechanism **6**, the concave portion **52a** is allowed to engage with the convex portion **51a**. Upon the engagement of the concave portion **52a** with the convex portion **51a**, the slider **51** is interlocked with the plunger **52** and then moves in the direction of the lens movement axis A FIG. 11B. The slider **51** moved in the direction of the lens movement axis A together with the plunger **52** is allowed to stop when it abuts onto a stopper. When the plunger **52** is further pushed in toward the direction of the lens movement axis A, the concave portion **52a** is disengaged from the convex portion **51a**, and thus the engagement of the slider **51** with the plunger **52** is released. As a result, the plunger **52** becomes movable independently, and the lens **2** is pushed out by the plunger **52**.

Even for the slider **51** that is not provided with the operating part, the loop guide **24** and the lens holding part **25** may be provided.

We claim:

1. A method, comprising the steps of:

pushing an unfolded intraocular lens, having an optic part with a first optical surface, a second optical surface opposite the first optical surface, and an outer edge between the first and second optical surfaces out of a lens placement portion of an injector having a plunger and into a tapered transition portion such that a portion of the optic part is on a central lens traveling axis of the tapered transition portion;

folding the unfolded intraocular lens as the intraocular lens moves along the central lens travelling axis and through the tapered transition portion by applying a force to the first optical surface of the portion of the optic part that is on the central lens travelling axis, and in a direction transverse to the central lens travelling axis, while the tapered transition portion engages laterally spaced portions of the outer edge and folds the intraocular lens about the portion of the first optical surface to which force is applied; and

pushing the folded intraocular lens along the central lens travelling axis, out of the tapered transition portion and through a nozzle.

2. A method as claimed in claim 1, wherein

pushing an unfolded intraocular lens comprises pushing the unfolded intraocular lens with a slider out of the lens placement portion and into the tapered transition portion.

3. A method as claimed in claim 1, wherein

the first optical surface of the folded intraocular lens is in compression and the second optical surface of the folded intraocular lens is in tension.

4. A method as claimed in claim 1, wherein

folding the unfolded intraocular lens comprises folding the unfolded intraocular lens by moving the intraocular lens

14

with a slider, which is movable relative to the plunger, along the central lens travelling axis and through the tapered transition portion while applying a force to a portion of the first optical surface of the intraocular lens on the central lens travelling axis with the slider and in a direction transverse to the central lens travelling axis while the tapered transition portion engages laterally spaced portions of the outer edge and folds the intraocular lens about the portion of the first optical surface to which force is applied.

5. A method as claimed in claim 4, wherein

pushing the folded intraocular lens comprises pushing the folded intraocular lens with the plunger along the central lens travelling axis, out of the tapered transition portion and through the nozzle.

6. A method as claimed in claim 4, further comprising the steps of:

preventing movement of the plunger prior to movement of the slider; and

permitting movement of the plunger in response to movement of the slider.

7. A method as claimed in claim 1, wherein

pushing the folded intraocular lens comprises pushing the folded intraocular lens with the plunger, that is movable relative to a slider, along the central lens travelling axis, out of the tapered transition portion and through a nozzle.

8. A method as claimed in claim 1, further comprising the steps of:

storing the unfolded intraocular lens in an unfolded state in the lens placement portion.

9. A method for use with an intraocular lens having an optic part with a first optical surface, a second optical surface opposite the first optical surface, and an outer edge between the first and second optical surfaces, the method comprising the steps of:

pushing the intraocular lens with a slider, which is movable relative to a plunger, along a lens travelling axis, out of the lens placement portion and into the tapered transition portion;

deforming the intraocular lens as the intraocular lens moves along the lens travelling axis and through the tapered transition portion by applying a force to a portion of the first optical surface of the intraocular lens in a direction transverse to the lens travelling axis while the tapered transition portion engages laterally spaced portions of the outer edge and folds the intraocular lens about the portion of the first optical surface to which force is applied;

pushing the deformed intraocular lens along the lens travelling axis, out of the tapered transition portion and through a nozzle;

preventing movement of the plunger prior to movement of the slider; and

permitting movement of the plunger in response to movement of the slider.

10. A method for use with an intraocular lens having an optic part with a first optical surface, a second optical surface opposite the first optical surface, and an outer edge between the first and second optical surfaces, the method comprising the steps of:

pushing the intraocular lens along a lens travelling axis, out of a lens placement portion and into a tapered transition portion;

deforming the intraocular lens by moving the intraocular lens with a slider, which is movable relative to a plunger, along the lens travelling axis and through the tapered

15

transition portion while applying a force to a portion of the first optical surface of the intraocular lens with the slider in a direction transverse to the lens travelling axis while the tapered transition portion engages laterally spaced portions of the outer edge and folds the intraocular lens about the portion of the first optical surface to which force is applied; and

pushing the deformed intraocular lens along the lens travelling axis, out of the tapered transition portion and through a nozzle;

wherein the slider includes an abutment part that engages the lens outer edge and a lens holder that extends beyond the abutment part and over the first optical surface.

11. A method as claimed in claim **10**, further comprising the step of:

pivoting the lens holder into contact with the portion of the first optical surface.

12. A method as claimed in claim **10**, further comprising the steps of:

driving the lens holder into contact with the portion of the first optical surface with the tapered transition portion as the slider moves along the lens travelling axis and through the tapered transition portion.

16

13. A method, comprising the steps of:

pushing an unfolded intraocular lens, having an optic part with a first optical surface, a second optical surface opposite the first optical surface, and an outer edge between the first and second optical surfaces, along a lens travelling axis, out of a lens placement portion and into a tapered transition portion;

folding the unfolded intraocular lens as the intraocular lens moves along the lens travelling axis and through the tapered transition portion by applying a force to a portion of the first optical surface of the intraocular lens on the lens travelling axis and in a direction transverse to the lens travelling axis while the tapered transition portion engages laterally spaced portions of the outer edge and folds the intraocular lens about the portion of the first optical surface to which force is applied;

pushing the folded intraocular lens with a plunger, that is movable relative to a slider, along the lens travelling axis, out of the tapered transition portion and through a nozzle;

preventing movement of the plunger prior to movement of the slider; and

permitting movement of the plunger in response to movement of the slider.

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